Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2020-274-AC2, 2020

Atmospheric Chemistry and Physics Discussions
Open Access

Interactive comment on "Remote sensing of methane leakage from natural gas and petroleum systems revisited" *by* Oliver Schneising et al.

Oliver Schneising et al.

oliver.schneising@iup.physik.uni-bremen.de

Received and published: 25 June 2020

We would like to thank both reviewers for their efforts in thoroughly reviewing our manuscript and for their constructive comments, which helped to further improve the paper. In the following, we provide answers and clarifications to all comments of the referees (repeated in italics).

Anonymous Referee #1

Reviewer: *In terms of comments and suggestions for revision of the paper, there is not much more to recommend. The paper was a pleasure to review. The one thing,* *however, that the authors should address is the findings of the recent paper by Zhang et al. (2020). I realize that the latter appeared after the submission of the Schneising et al. paper, but the two have so much in common, yet rather different messages, that it would be remiss not to have the authors discuss it. This could, perhaps, be handled in Discussions, but since many readers will just download the manuscript and forego the Discussions, they would miss out on a key aspect of the work.*

To initiate the discussion, it is very interesting that the two papers, using quite different analysis methods (Zhang et al. used TROPOMI data with a Bayesian inverse), produce almost identical (within uncertainties) estimates for total fugitive CH4 emissions for the Permian. This is remarkable in its own right. What is more striking, however, is the difference in messaging. The two produce very different qualitative assessments (i.e., 'spin') of their policy implications. In one case (Schneising et al.), the emissions are framed as acceptable: "below the break-even rate for immediate climate benefit", while in Zhang et al. the fugitive emissions are regarded with alarm: "Permian Basin appears to be associated with insufficient infrastructure ... leading to extensive venting and flaring (Fig. 3), which contributes to high methane emissions." Besides the technical difference of how CH4 emissions are related to the total energy production (divisor for the waste percentage), it seems that preconceptions are influencing how the results are discussed. While both papers reach the obvious conclusion that much more can and should be done to limit fugitive emissions, we need a balanced consideration of how to use the satellite data to that effect. Note how the press took off with the Zhang et al. paper: https://www.newscientist.com/article/2241347-fracking-wells-in-the-us-are-leaking-loads-of-planet-warming-methane/. At a minimum the authors Schneising et al. should put the percentage waste estimates on the same divisor, address any other discrepancies, e.g., the relation to prior estimates, and, hopefully, initiate an informed discussion on how to use these results for progress in reducing effective emissions.

Authors: We agree that the findings of the Zhang et al. (2020) paper (which appeared after the submission of our paper) should be discussed and set in relation to our results. In the revised version, we have added a paragraph describing the differences in the two approaches and comparing the corresponding results. We also explain, why we think that our method of computing the leakage rate, which we have already used in earlier work, is better suited to assess the climate impact compared to coal. The new paragraph reads as follows:

"Concurrent with our study, Zhang et al. (2020) also quantified methane emissions from the Permian basin using a different data set and an alternative inversion method combining information from the operational TROPOMI methane product and prior emission estimates within a Bayesian framework. Despite these quite distinct approaches, their total emission estimate of 2.9 ± 0.5 Mt yr^{-1} based on satellite observations from May 2018 to March 2019 agrees within uncertainties with our estimate. If we restrict our analysis to this specific period, the consistency becomes even better and we get the almost identical estimate of 2.8 Mt yr^{-1} with our method, which is independent of prior knowledge. Therefore, the corresponding absolute results are considered very robust. However, there is a crucial difference in the calculation and subsequent interpretation of the leakage rate: while our rate (1.3%) is calculated relative to combined oil and gas production in terms of energy content (Schneising et al., 2014), the rate of Zhang et al. (2020) is larger (3.7%) and appears more alarming because it is put in relation to natural gas production only. With this alternative divisor we would also get a leakage rate of 3.7% (as can be determined from Table 1). But as the Permian is dominated by oil production, we consider the total energy approach to be better suited to assess the climate impact compared to coal in general. Otherwise, the energy content of the extracted oil would be neglected and a pure oil play (with an infinitesimal fraction of not marketed but vented natural gas) would have a leakage rate of 100%. For a pure natural gas play, however, both approaches to determine the leakage rate coincide."

Anonymous Referee #2

Specific comments

Reviewer: *... I do agree with Reviewer #1 on the importance of considering the recently published Zhang et al. (2020) results in this work - this addition will further increase the quality of this paper. Regarding the Reviewer's comment on how to communicate the results, I appreciate Schneising et al.'s discreet voice of describing the results and conclusions.*

Authors: We have added a corresponding paragraph in the revised version. See also answers to Referee #1.

Reviewer: *Section 2: The authors do a thorough job in explaining criteria that they have found necessary for selecting the data in order to produce reliable emission estimates. I'm curious how demanding these criteria are; which one is the most excluding or is this case-dependent? I assume these criteria were set by experimenting. Are the criteria equally good for all cases?*

Authors: We have added a dedicated paragraph and a corresponding figure to Section 3.7 of the manuscript:

"Section 2 also describes the filter criteria for selecting the data in order to ensure reliable emission estimates. Most excluding are the ones that filter out days with too few data coverage over the corresponding region. To determine the subsequent order of the leftover filters, the criteria excluding the most days of the remaining data set are successively identified. The results are summarised in Figure 12 for different oil and gas plays under consideration. The filter criteria ordered by exclusionary power for all regions combined are: 1) too few data, 2) too high background scatter $\sigma(E_b)$, 3) too high or too low wind velocity v, 4) too large asymmetry $|\bar{E}^N_{b,p} - \bar{E}^S_{b,p}|$ with respect to the equator, 5) considerable wind direction change within the 2 hour time window of wind history, 6) too large daily uncertainty u_Φ. For the individual regions, the respective filter sequences are similar with a maximum permutation of two criteria compared to the overall sequence."

Reviewer: *Page 11, lines 2-5: The authors comment that the actions to reduce fugitive emissions have been successful. Are these actions potentially mentioned or described in any citable source? I think this is a strong point towards verifying climate actions and reaching company sustainability goals but would be interesting to know what kind of actions have taken place and when.*

Authors: We have added a sentence describing the kind of actions that have taken place with corresponding references to Section 3.2:

"The systematic measures implemented proactively by coalitions of oil and gas companies since 2014 to continuously reduce methane emissions include additional leak detection and repair campaigns, replacement or upgrade of high-emitting devices, and reduction of venting or flaring, to direct toward the ambitious goal of achieving a leakage rate not exceeding 1% across the natural gas supply chain (including a maximum of 0.3% from upstream operations) by 2025 (ONE Future, 2019; Oil and Gas Climate Initiative, 2019)."

Reviewer: *Section 3.7: Does the selected resolution of the XCH4 gridding affect your results? Did you experiment with different grid resolutions?*

Authors: We have not experimented with different grid resolutions and expect only a small impact on the results. The selected grid resolution was chosen because it is close to the native resolution of the TROPOMI instrument.

Technical corrections

Reviewer: *Figures 4, 5, 7, 8, 10 captions: coordinate E should be W*

Authors: Has been changed in the revised version.

Reviewer: *Figure 11 caption: coordinate W should be E*

Authors: Has been changed.

Reviewer: *Page 4, line 27: straight-forward should be straightforward*

Authors: Has been changed.

Reviewer: *Eq. (1) lacks period from the end.*

Authors: Has been added.

Reviewer: *Eq. (3) lacks period from the end.*

Authors: Has been added.

Reviewer: *Page 7, line 24: remove comma after "note"*

Authors: Has been removed.

Reviewer: *Page 8, line 2: 5 $\rightarrow$ five*

Authors: Done.

Reviewer: *Figure 6 (also elsewhere): spelling of the time interval could be harmonised (2009-2011 but 2018/2019).*

Authors: We would like to keep the original spelling: "/" for a list of specific years and "-" for a period (which is longer than two years) with start and end year.

Reviewer: *Page 14, line 10: a $\rightarrow$ an*

Authors: Done.

References

Oil and Gas Climate Initiative: Scaling up action - A report from the Oil and Gas Climate Initiative, available at: https://oilandgasclimateinitiative.com/annual-report/ (last access: 2 June 2020), 2019.

ONE Future: 2018 Methane Emission Intensities - A Progress Report, available at: https://onefuture.us/wp-content/uploads/2019/11/ONE-Future-2018-Final-Report-LN.pdf (last access: 2 June 2020), 2019.

Zhang, Y., Gautam, R., Pandey, S., Omara, M., Maasakkers, J. D., Sadavarte, 5 P., Lyon, D., Nesser, H., Sulprizio,M. P., Varon, D. J., Zhang, R., Houweling, S., Zavala-Araiza, D., Alvarez, R. A., Lorente, A., Hamburg, S. P., Aben, I., and Jacob, D. J.: Quantifying methane emissions from the largest oil-producing basin in the United States from space, Science Advances, 6, https://doi.org/10.1126/sciadv.aaz5120, 2020.

Interactive comment on Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2020-274, 2020.